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A Comprehensive Process Improvement Methodology: Experiences at Caterpillar's Mossville Engine Center (MEC)

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Executive Summary

Since the beginning of the 1990s, business process reengineering (BPR) has received considerable attention from the management information systems (MIS) community (Caron et. al, 1994; Davenport, 1993). However, dramatic improvements touted by BPR advocates have failed to materialize in many organizations (Hammer and Champy, 1993; Kotter, 1995). Current research has provided limited explanatory power concerning the underlying reasons behind BPR failure. Hence, in–depth research is needed into companies experimenting with BPR.

This case provides a longitudinal view of Caterpillar Inc. Mossville Engine Center experiences with BPR since 1991. It describes how Caterpillar Inc. (Peoria, IL) introduced BPR into one business unit, Mossville Engine Center (MEC), five years ago and saved between US $10 and $20 million. Caterpillar believes that its success with process improvement can be directly tied to adoption and implementation of an enterprise–wide methodology called Business Process Simplification and Improvement (BPS/I). BPS/I provides a systematic methodology for analysis, design, and implementation of reengineering principles. The methodology provides the structure, techniques, and new job roles to effectively implement redesigned business processes. The role of information technology includes facilitation of data transformation, information flow, and communication through each stage of the BPS/I methodology.

The case was co–authored by the Process Improvement Manager. His job was to facilitate, instruct, and oversee BPR initiatives. Information was gathered via in–depth interviews, observation,

company documentation, and consultant information. Our hope is to introduce mechanisms and guidelines to help other firms effectively implement and manage BPR initiatives.

Background

Caterpillar MEC manufactures a variety of small–and–medium–sized diesel engines. The engine center employs approximately 5000 people with 1,200 in management positions. Total revenue for Caterpillar Engine Division is approximately US $3.7 billion.

Historically, the management style has been hierarchical with top–down decision making and bottom–up reporting. Line workers are assigned specific tasks and must adhere to specifications provided by project leaders and managers. Managers are provided directives from upper management and are allowed some latitude in how they delegate assignments. Top management creates directives from long–term strategic plans, decides on priorities for major projects, develops the corporate vision, and communicates the vision to employees.

Setting the Stage

Caterpillar Inc. embarked on a long–term strategy to grow its businesses and rethink existing business units and divisions. Over a seven–year period, beginning in 1987, Caterpillar invested US $1.8 billion in a plant modernization program. The modernization effort enabled the company to improve quality, reduce waste, and helped the Engine Division grow its diesel engine business. In 1990, Caterpillar began a corporate–wide effort to reorganize its business. Its goal was to replace its centralized organization with a decentralized business unit organization focused on meeting customer needs and improving the bottom line. Today, Caterpillar has 17 business units.

In 1991, BPS/I was introduced in several Caterpillar businesses. BPS/I utilizes proven correction, simplification, and reengineering techniques to improve both office and factory business processes. Historically, operational processes have always undergone continuous scrutiny. However, office processes had received little attention. Hence, Caterpillar has shifted its focus to improving inefficient and ineffective office processes.

Formerly, small engine production was part of a larger profit center; consequently, its productivity wasn't as closely scrutinized. As an independent business, Small Engine Products now had to turn a profit in a business that has a lot of competitors and tight profit margins. Small Engine Products management believed that business survival dictated an "improve or perish" mentality. Moreover, it appeared that administrative and cultural changes would be needed to prosper in the future. For these reasons, Small Engine Products management turned to BPS/I.

BPS/I training has two facets. First, candidates undergo intensive training concerning every aspect of BPS/I. Second, they are trained in how to effectively train others. The training isn't over until trainees can effectively demonstrate an ability to train others. Once trainees have successfully completed the program and their performance with a real team has been monitored, they go back to their project as instructor/facilitators (I/F); that is, they are responsible for training and facilitating all team members involved in the BPS/I project. Training local managers is advantageous for two reasons. First, developing instructor/facilitators provides in–house expertise. Second, I/F have deep knowledge of the business at Small Engine Products and can thereby guide BPS/I projects in ways that add value to the business.

Case Description

Organizational transformation continues at Caterpillar. The Small Engine Products business and the Medium Engine Products business have combined to form the MEC. MEC is the business being analyzed throughout the remainder of this case.

Case study analysis of Caterpillar MEC began over four years ago (summer of 1992). Since that time, we have synthesized information from over four dozen BPR initiatives into a set of guidelines and strategies for successful BPR. Projects both large and small have been completed in all MEC business processes. Processes such as engineering, new product introduction, concurrent production, process design, orders, customer support, information systems, and logistics have been beneficiaries. Each of these projects is large in scope; that is, they span functional boundaries and management levels.

Over the past four years, contact was maintained via telephone, e–mail, and fax. The next site visit is tentatively scheduled for Spring 1997. Data was gathered by in–depth interviews, extensive observation, company documentation, consultant information, and the personal experiences of the researchers. The breadth and depth of data collected is extensive as one of the authors is also a key champion of Caterpillar BPR initiatives. He is the BPS/I coordinator and contributes over 28 years of inside experience.

Success centers around the ability of an organization to establish and maintain a systematic BPR methodology like Caterpillar's BPS/I. Hence, data was collected concerning the structure of BPS/I, key factors driving the success of the methodology, and issues surrounding implementation. *For confidentiality reasons, detailed financial analysis was not included.*

Overview of the Case

BPS/I is the "roadmap" for reengineering at Caterpillar. It provides a team structure to help BPS/I teams better deal with process problems. It also offers a systematic methodology for developing and

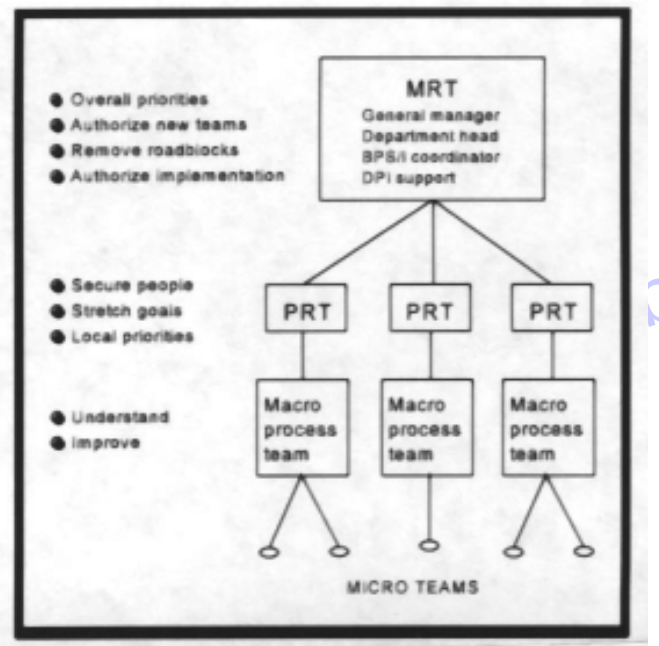

Figure 1: BPS/I Team Structure

implementing process solutions. Following is a detailed discussion of the BPS/I team structure and methodology.

BPS/I Structure. The BPS/I structure consists of a team hierarchy for attacking process problems, as depicted in Figure 1. The hierarchy includes:

- management review team (MRT)
- project review teams (PRT)
- macro process teams
- micro process teams (when deemed necessary)

I/F train and coach process teams. I/F assist and support all levels of the structure by teaching and overseeing the reengineering process. The reengineering coordinator works closely with top management and counsels I/F.

The MRT is the governing body that consists of the General Manager, department heads, BPS/I coordinator, and invited guests depending on the process being considered. The MRT selects and authorizes business processes to be examined that have critical links to Caterpillar business strategies. The "results–oriented" mentality of the company requires that each process meet the twin criteria of potential to reduce costs and provide a high business strategic value. The MRT also guides projects by interacting with the PRT and macro process teams. Senior management buy–in is sought early on because BPS/I projects do not begin until authorized by the MRT. Since the MRT has top management membership, it can also remove political and cultural roadblocks that may hinder the PRT or process team progress.

The PRT consists of mid–to–upper–level managers familiar with the specific process being improved. The PRT sets stretch improvement goals and selects macro process team members. Caterpillar management wants project goals to be stretched to an ever higher level of performance. It also facilitates macro process team activities and communicates the importance of the project to the company. The PRT structure reduces failure as middle managers are forced to work with people on the floor; thereby they gain a better understanding of the process. In addition, it is charged with communicating top management initiatives to the people on the floor. The PRT acts as the communication link between top management and process workers. It is also charged with preparing process teams for final presentations to top management. Process team performance is thereby a direct reflection on the PRT. Quality is improved because everyone in the organization understands the importance of the project and plays an important role in its success.

Macro process teams are cross–functional with six to eight members. Team composition consists of workers who actually perform the process and a supervisor or mid–level manager. Macro process teams recommend detailed process changes. Once the changes are approved, they are the ones who actually do the work. For large processes, a macro process team may form a micro process team to better manage individual issues and details. However, micro teams are only formed out of extreme necessity as coordination problems are greatly intensified with the creation of multiple sub–teams. Process team buy–in is promoted by requiring each team member to sign a BPS/I mission statement for each project. The mission statement serves two purposes. It shifts ownership of the project from management to the team and forces team members to make a commitment. The mission statement includes what they will provide the customer, a time frame for completion, and the level of improvement expected.

Besides process team buy–in, MEC management wants team members to better understand the overall MEC small engine business and adopt a "continuous improvement" mentality. In order to achieve these results, management has attempted to create an environment that encourages teams to challenge status quo processes. Management encourages "out of the box" thinking by involving teams in the decision–making process. MEC experiences with team involvement is that it has dramatically

improved team member understanding of the business.

To avoid miscommunication and promote understanding, each level of the BPS/I teamstructure includes at least one member from the level below. The MRT level seats at least one PRT manager (the process owner) as a permanent member. Each PRT level seats at least one macro process team member (the team leaders). Macro process team members lead micro process teams. The BPS/I structure keeps people at all levels informed as it introduces lines of open communication up and down the organization. Managers understand what teams are doing, and teams understand what is important to managers.

The structure sends the message to everyone that it is okay to tinker with existing processes and challenge process paradigms. An environment conducive to involvement is especially important for politically sensitive processes. The people involved in BPS/I need to hear that management supports critical examination of the existing process. Training becomes a key issue because employees in the process may have had little or no previous decision–making experience. Caterpillar had the foresight to commit to training early in the process to help its employees ascend the BPS/I learning curve more quickly.

Caterpillar is committed to BPS/I, however, the structure is only a mechanism to address process reengineering problems. The company has to continue to function during the transition period required by BPS/I. In the meantime, it must satisfy existing customers, stockholders, employees, and other stakeholders. MEC employs a full–time coordinator to act as liaison. Facilitator coordinators work directly with the general manager and department heads. They also facilitate the effort at all levels of the BPS/I hierarchy. In sum, facilitator coordinators are charged with keeping everyone involved in reengineering aligned with the BPS/I methodology. The next section details the steps involved in BPS/I.

BPS/I Process. As depicted in Figure 2, the BPS/I implementation process has five main steps —process selection, process mapping, process improvement, process verification, and process implementation. Each of these steps are discussed in this section.

Process selection. The first step for the MRT is to select critical business processes based on their potential to add value to Caterpillar businesses. A critical responsibility of the MRT, at this step, is to ensure that project guidelines are aligned with business strategies and objectives. The PRT is formed. The PRT secures people for the teams and establishes local priorities based on the MRT plan. Macro process teams are charged with doing the work. After process selection, the processes can then be mapped.

Process mapping. The goal of process mapping is to understand the current process or set of processes and associated problems. Project limitations and the process mission are also established at this step. Process mapping is the most important step as it provides a full view of the process in its entirety, both upstream and downstream along the process path.

Under the periodic guidance of the PRT, macro process teams begin developing a crude map of the process. The map portrays the flow of activities along the process path. Teams use flowcharting to map process flows. Flowcharting is a useful tool as it facilitates understanding and communication. It helps teams identify dangerous loops, redundancies, and incomplete instructions in the process. It also helps teams understand what the process looks like and how changes will alter tasks and activities along the process path. The team can then tweak or radically alter process flows by using the flowchart as a guide. In addition, teams can use flowcharts to facilitate communication with management concerning proposed process changes. The first map is crude by design. Allowing teams to develop the map with their own hands serves two purposes. The team gets more involved in the creative process, and the map acts as a rallying point for team members. Project ownership shifts to the team as they feel like they are in charge. The map allows them to begin identifying redundancies to remove.

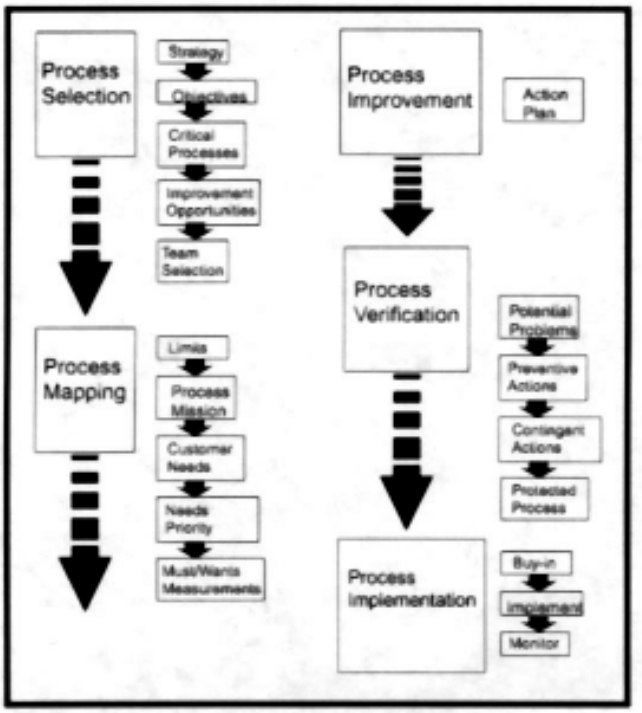

Figure 2: BPS/I Steps

It also acts as a catalyst to begin questioning the accepted process norms. Team members start asking why the process is done in a certain way and why can't it be done in a better way. Related training manuals provide appropriate prompts to the team along the way. Having defined problems associated with the current process, team members are now ready to suggest improvements.

Subsequent drafts of the process map are placed in electronic form with the aid of software flowchart packages such as AllClear. Other tools that are used include pareto analysis (tracks quality), affinity diagrams (for degree of quality), and fishbone diagrams (identify where problem occurs along the process path).

Process improvement. After the team maps the process, process improvement begins. Process improvement involves analysis of existing processes and suggestions for change. Caterpillar believes that process improvement need not be radical. A process can be corrected, simplified or reengineered. Figure 3 depicts the three improvement methods.

At Caterpillar, process improvement usually begins with simplification. Simplification involves streamlining the existing process. If analysis of the process calls for removal of one or more steps, simplification is being used. Smallest in scope is process correction. Correction involves returning the process back to traditional levels of performance. Correction is only used if the current process is performing below traditional levels of expectation. Reengineering involves major (radical) changes to the existing process. Reengineering forces a change in the team's thought processes. They have to rethink the way a job is currently done. Reengineering techniques are often employed in conjunction with simplification. It is not unusual for all three methods to be used on a single process.

The improvement method— process simplification, correction, reengineering — is arrived at during the process improvement step of BPS/I. The team begins process simplification by asking questions about the activities currently being performed: what are the activities, where are they

performed, when are they performed, how are they performed, and who performs them. In the next step, the team questions why process activities are done in a certain way. This is a very important question as it breaks status quo thinking. It forces teams to question the logic of a process. In the third step, the team questions the necessity of each process activity. Finally, the team devises alternative ways to perform the process. Reengineering is very similar to simplification except teams are expected to devise alternatives that provide radical rather than incremental improvements.

A common technique to approach process improvement is to break down the process into smaller parts—modular problem solving. Using this technique, teams attempt to find ways to simplify, correct, or reinvent smaller portions of the whole process. They then decide on the implementation priority of each remedy. After priorities are set, the team verifies that each one will work as expected. As simple as this seems, teams are not used to thinking on their own.

Hence, I/F use graphics to facilitate understanding. For instance, teams are shown a graphic depicting a bad condition with many complexities such as a six–foot gorilla. Another graphic shows the problem broken down into manageable components as several monkeys, as depicted in Figure 4. The question is then posed,"Would you rather take on a six–foot gorilla or six, one–foot monkeys?" Caterpillar is also aware of the potential of technology to facilitate process improvement. Teams have e–mail to communicate with each other and management, personal computers to analyze data and document/graph activities, and access to mainframe power to handle larger jobs.

The major deliverable out of the process improvement step is a generation of alternative process flows. Teams are provided tools to help with the analysis, facilitative management for encouragement, and technology to communicate. However, they need a mechanism to stimulate idea generation. Caterpillar has found that the most effective mechanism for idea generation is brainstorming. Brainstorming is used extensively to encourage creative input from team members. Caterpillar has demonstrated its support for brainstorming by developing a set of seven rules as depicted in Figure 5.

Managers act as facilitators of the brainstorming process by allowing team members to voice their opinions and by reserving judgment. Proper management of brainstorming sessions is critical. Hence, a critical component of I/F training is learning how to create an "open" environment for employee ideas, acting as a coach or facilitator rather than a boss, and convincing employees that their ideas or comments will not lead to future reprisals. The next step in the methodology is to determine the ramifications of the suggested process changes.

Process verification. Once the team generates alternative process flows, verification of the choices can begin. In the process verification step, the team determines the impact of each alternative on the company as a whole. The team has made its own decisions and has assumed ownership of the project. At this point, the team is like a race horse. Its members believe that they have the answers and are ready to implement them. The I/F job is to slow down the team and help them assess the value of each alternative generated in the process improvement step. Caterpillar uses potential problem analysis (PPA) to counteract the tendency of teams to jump to conclusions without proper analysis. PPA engages teams to ask questions about the value of each alternative and its impact on other processes. The time allotted to PPA should be at least 1–1.5 hours for each alternative. Table 1 includes a set of possible questions that might be used for PPA.

Team PPA is facilitated by wall posters with questions and places where team members can fill in possible answers to the questions. The main objective of PPA is to identify potential problems associated with an alternative and anticipate the impact of changes required by an alternative on the existing process and other processes along the process path. Deliverables from PPA include a report of potential and anticipated problems associated with the new process. The team completes the PPA analysis keeping in mind what would happen to the existing process, customer satisfaction, and other

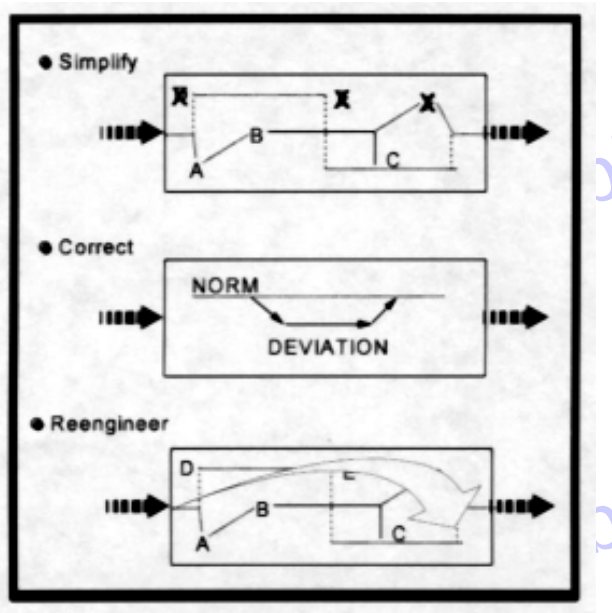

Figure 3: Three Improvement Methods

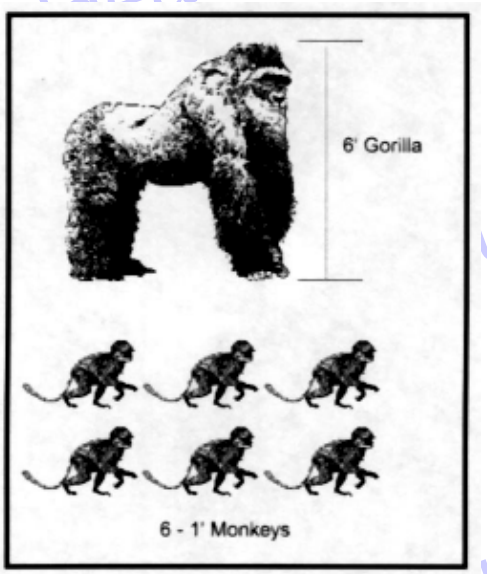

Figure 4: Divide and Conquer

processes if something went wrong. PPA should help ensure that the alternative chosen by the team will have the least negative impact on the organization and other processes along its process path.

Process implementation. The final step of BPS/I is to figure out how to implement the new process. The new process will have a refined process map and a thorough PPA report. The team meets with its PRT to lay out a proposal for presentation to the MRT. The proposal includes a detailed implementation plan, benefits of the new process, and a time table for completion of the project. The PRT acts to facilitate the completion of the proposal and helps the team get ready to present it to the MRT. After all, the PRT has a vested interest in the success of the project as they helped assemble

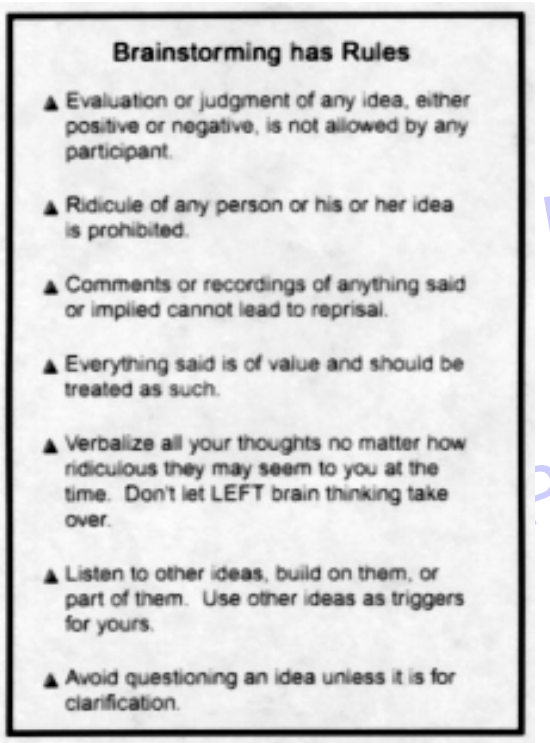

Figure 5: Brainstorming Rules

the team.

Technology Concerns

Caterpillar relies on a variety of computer platforms (ie., client/server and mainframe) to transform data into information and facilitate information flow along each step of the BPS/I methodology. Various technology platforms are being considered for future integration. Most team members involved in BPS/I projects use personal computers to facilitate simple data processing and end–user application development. These computers are connected into Caterpillar's telecommunications backbone which also connects to headquarters and the other main business sites.

Data is partially integrated across critical business processes via connections with the mainframe platform. Information is made available on a fairly consistent and timely basis for BPS/I teams along the five critical steps of the methodology. However, information is not available at the fingertips. Reports are processed through the mainframe system and sent to the requesting area by internal and electronic mail. The mail system is efficient, but cannot be compared to a networked personal computer. An important integrating tool is electronic calendaring. As meetings are scheduled, the calendaring system automatically checks everyone's schedule for conflicts. Everyone has access to the schedule via personal computers or dumb terminals in proximity of their work space. Employees have a short time frame to question the schedule. If no one requests a change, schedules are set in stone. The organization's experience with this system has been very favorable. Electronic calendaring has enabled integrated scheduling on an enterprise–wide basis.

MEC utilizes sophisticated technology and equipment at the process level. AutoCAD, Pro/E, and other information system tools are used to facilitate complex diagraming and blueprinting of